Track3DKalmanSPS update

Eric Church, 9-Dec-2011

Reminder: Icarus paper shows ~10% energy measurement for MC muons. They apply this to cosmics in a NIM paper.

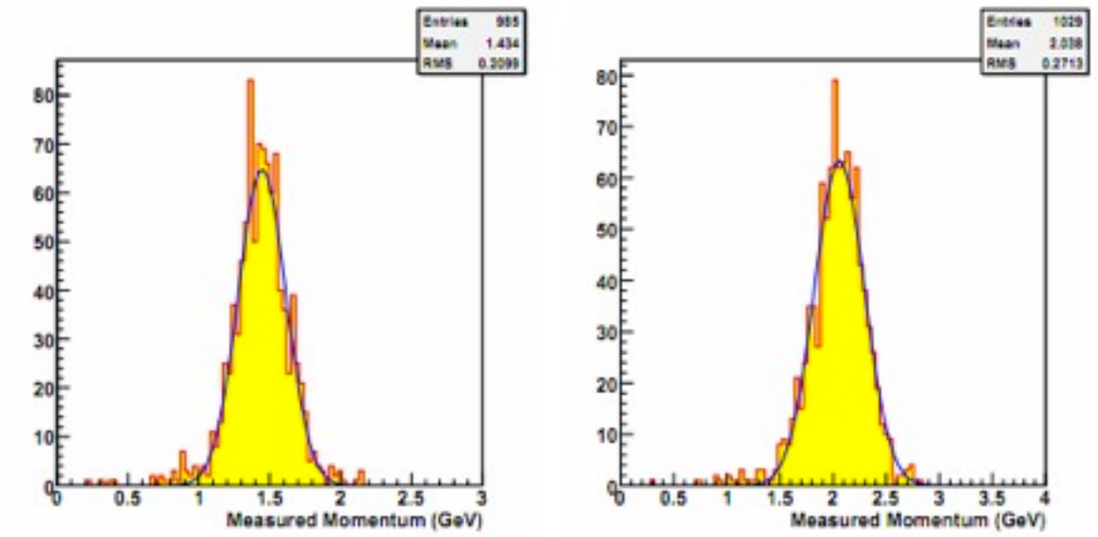
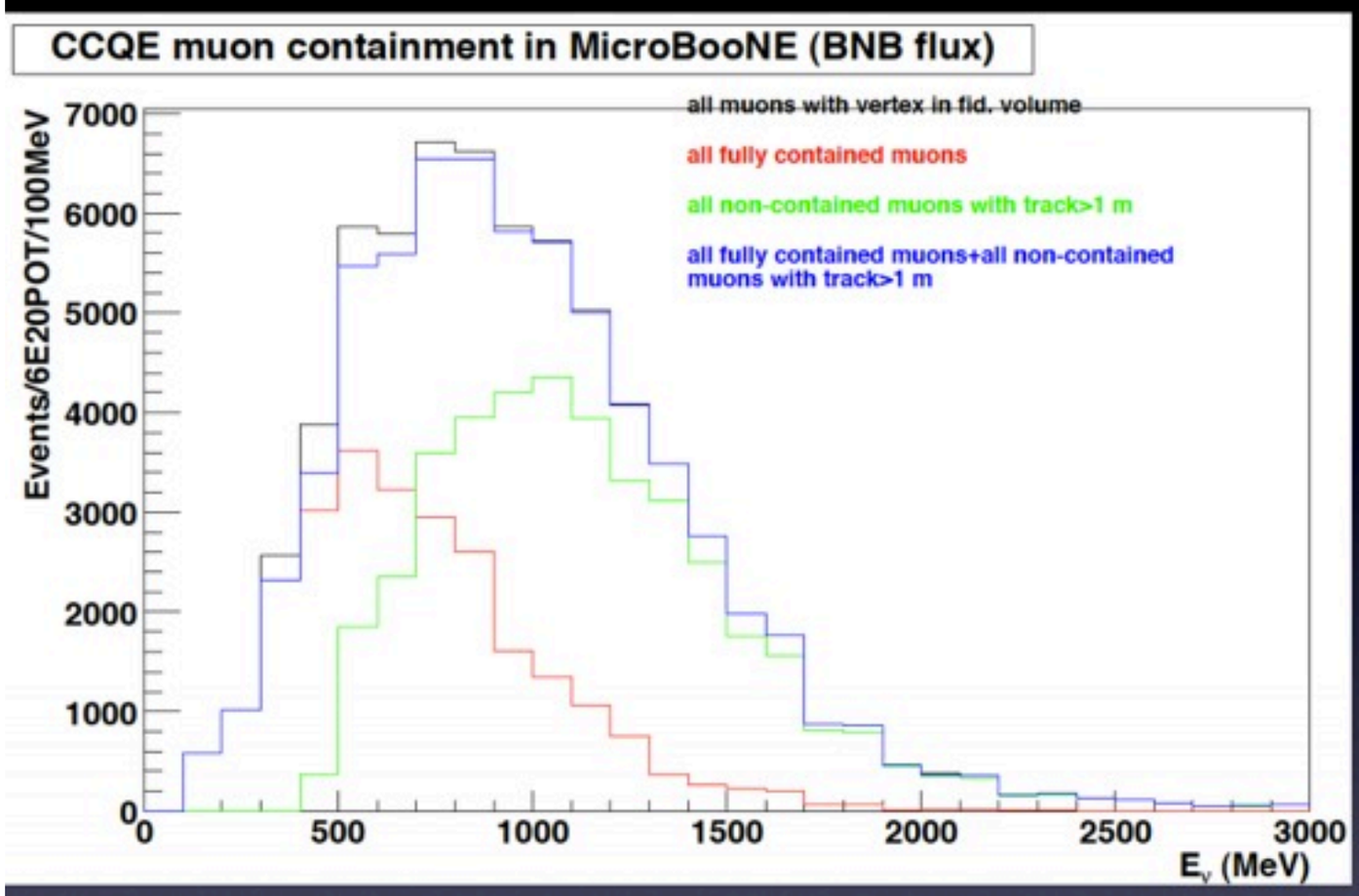


Fig. 5. Momentum distributions as given by the Kalman Filter for simulated muons of 1.5 and 2.0 GeV.

It is not simply enough to fit to fully contained tracks. Icarus claims ~20% resolution for 6-ish GeV/c muons too in results shown at NNN2011 (and other places probably). All due to multiple scattering.

From docDb783 (Josh)

Reconstructing the muon and muon containment



numu CCQE events simulated with GENIE->Geant4

~5% energy resolution

<25% energy resolution

Previous Status

- Had lovely <10% resolution on < 2.5 GeV/c MC muons, and then realized I was using MC hits.
- with useMC=false resolution is worse, cuz of jumpiness of spacepoints.
- Non-fully contained tracks were not resolved well and I made some specious claims that that's how life is.

I generate ~~250~~ 400 MC Muons in uBooNE

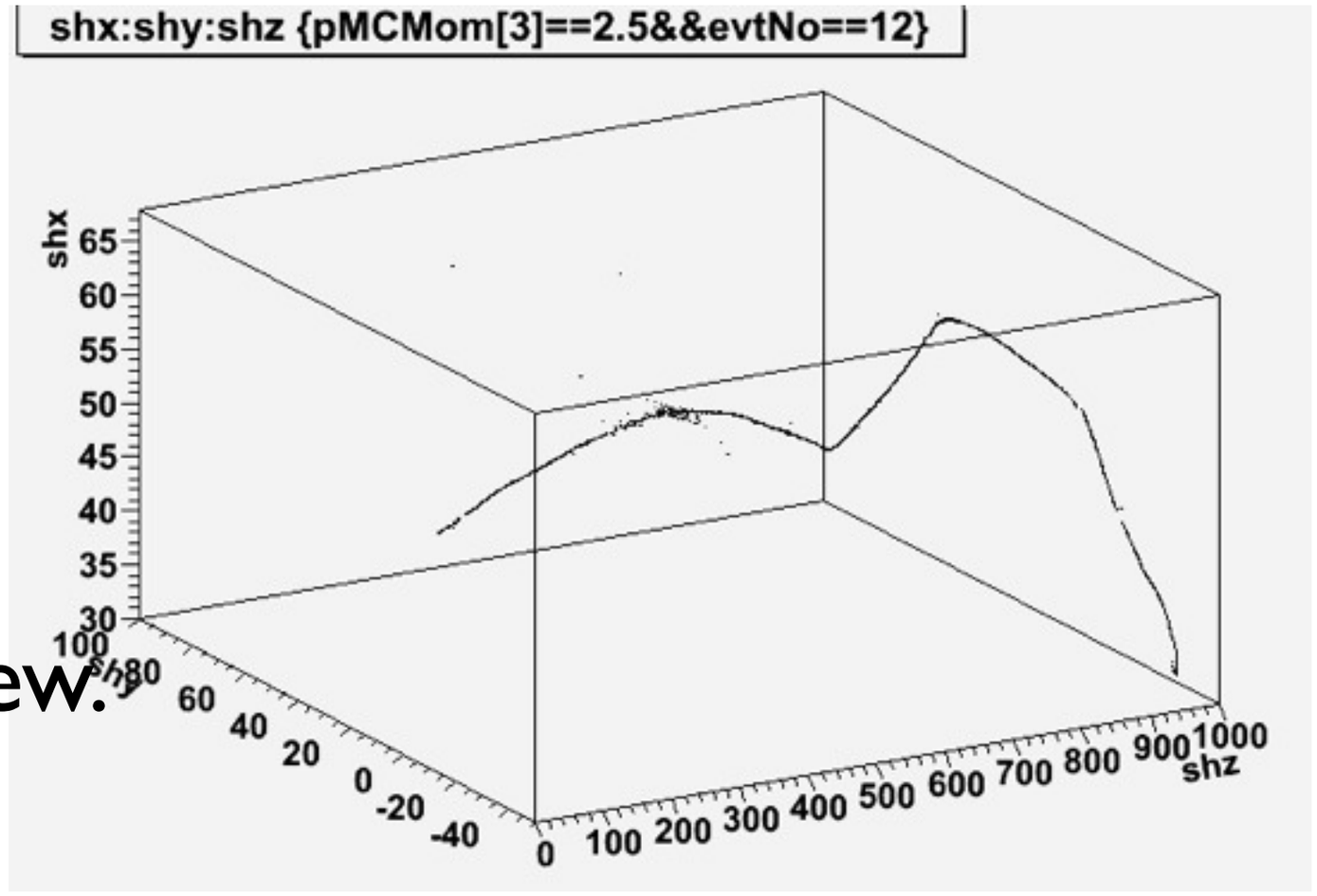
- Sampled at 0.5, 1.0, 1.5, 2.0, 2.5, 4, 7, 10 GeV/c
- Start them at (50,0,50) cm, with 15 deg variation in zy and zx pointing down TPC z axis.
- Remember: TPC is (0 to 250,-110 to +110,0 to1150) cm

Reconstruction

- SingleParticle, LArG4, SimWire, CalWire, HitFinder, **DBCluster** (Thanks, Dave McKee!). Sampling time=**198nsec**.
- Then I run module Track3DKalmanSPS. In it SpacePointServices is called. It loops over all combinations of clusters (one in each plane) and finds 3D spacepoints. Sort these in z.
- The Kalman filter runs a track in the usual Kalman way, discussed elsewhere, through those points.

PCA

- One thing new is I now do a Principal Components Analysis
- and disallow hits that are ~1 sigma off the main component.

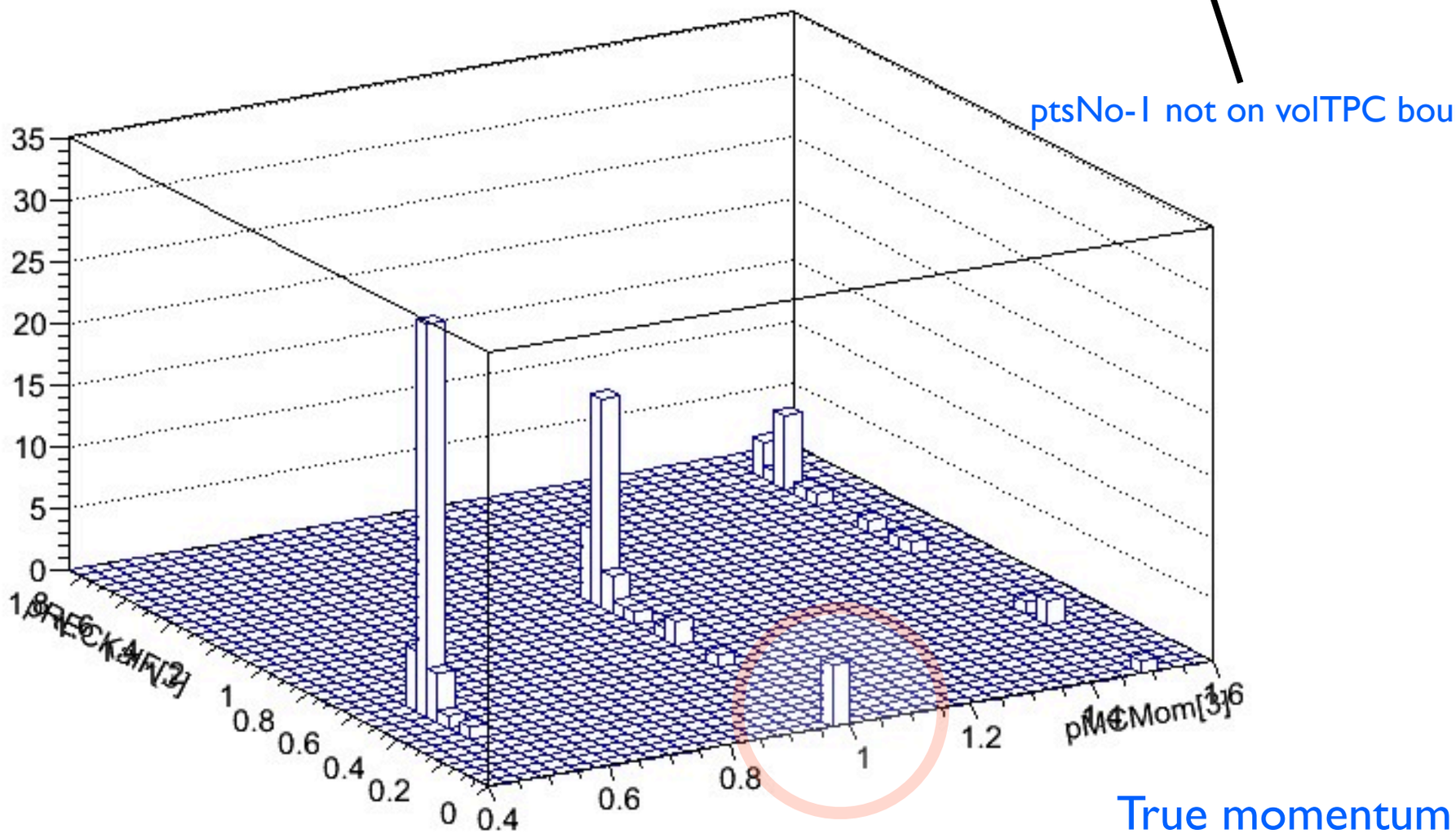


Not tuned. Brand new.
Not sufficient.

E resolution: 2 simple cuts

Require only ptsNo>200&&pRECKalF[3]>0.1 && containment

ptsNo-1 not on volTPC boundary



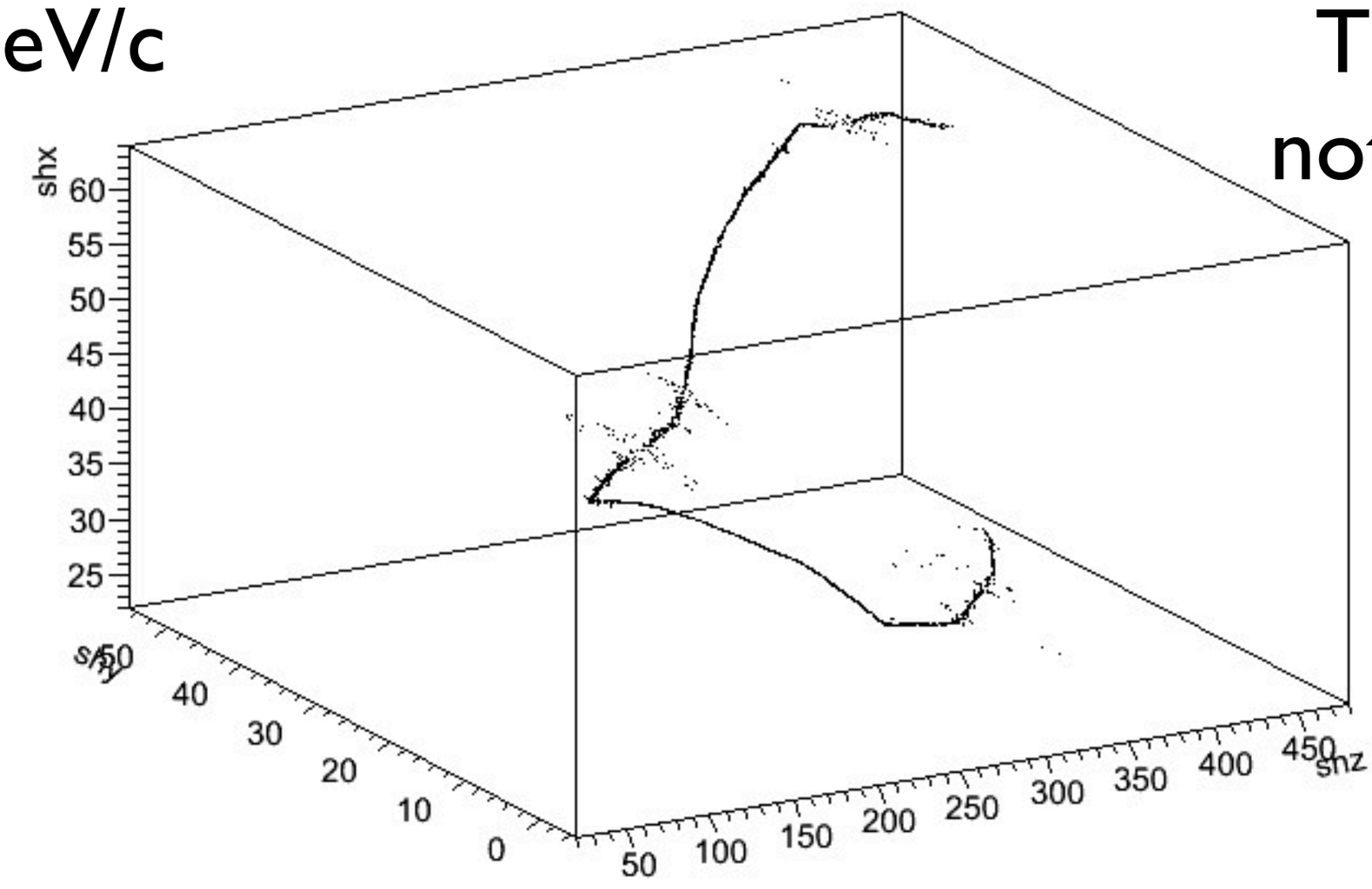
Reconstructed momentum

True momentum

Next page

Still problems with adjacent wiggy hits

p<2.5GeV/c

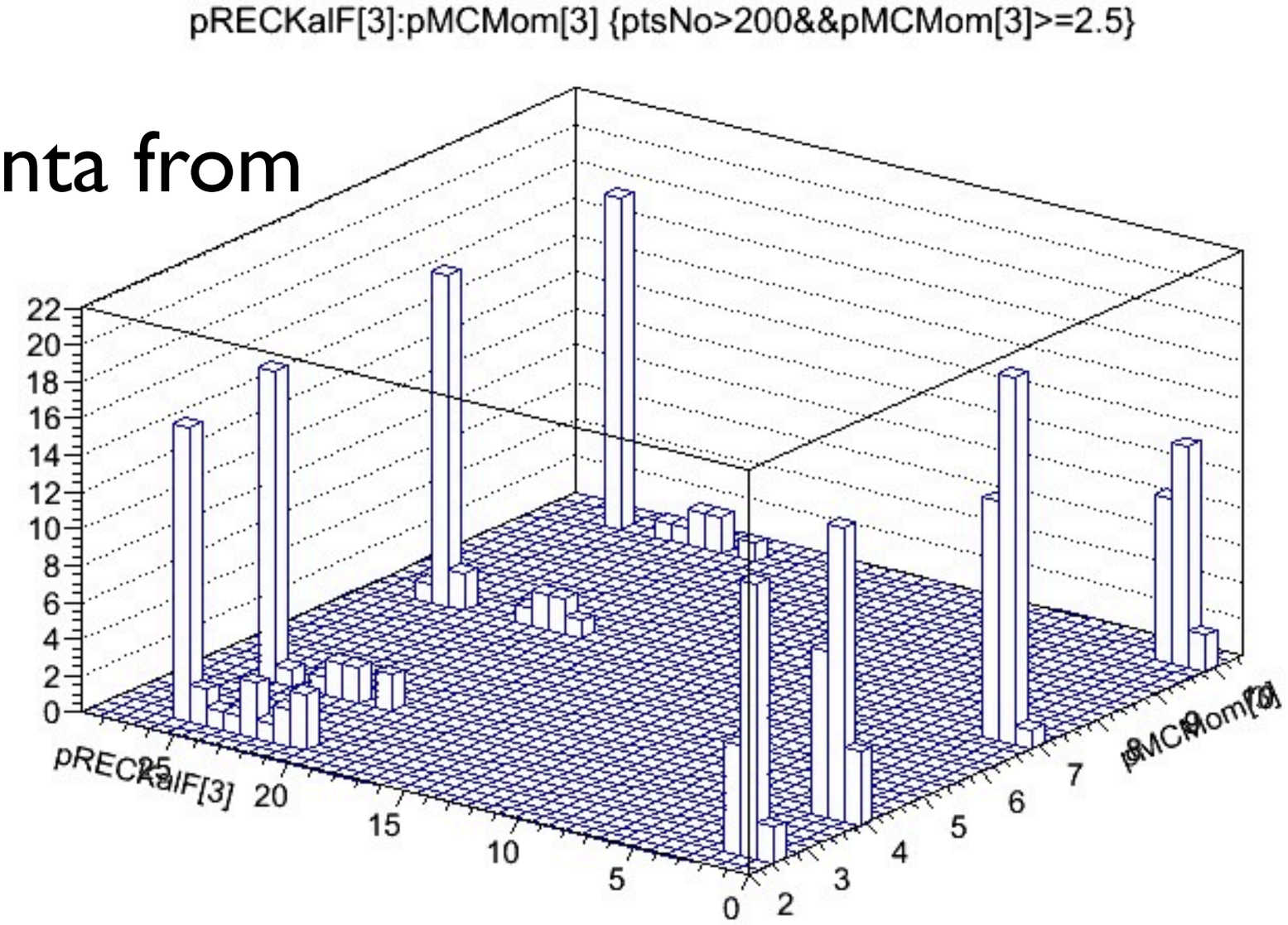


This seems not insoluble.

Not every track is fully contained.

- I'm doing terribly determining momenta from multiple scattering.

Meh!



starting values

- **Still** some fragility to starting momentum values.
- I set the 3-position of track at x,y,z of first spacepoint. I use ~1.20*2.2MeV/cm*(shx[last]-shx[0],shy[last]-shx[0],shz[last]-shz[0]) as starting 3-momentum. **And x10 for >2 GeV/c.**
- **I generally end up close to starting point, for all p.**

Multiple Scattering

- Theta ~ 14 MeV/p . sqrt (x/X_0) + O(ln terms)
- 17(25) cm deflection over 7m for a 4 (2.5 GeV/c) track.
- In Kalman filter this is handled as noise in the off diagonal covariance matrix elements. MS is the mechanism by which high through-going tracks are measured.
- Which translates to a bigger scatter in next step's momentum prediction
- It all *seems* correct.

Status/To Do

- Even with "True" hits delta rays scatter the spacehits and give extra noise. And Spacehits currently not entirely correct, because of electronics issues and hits produced.

- This leads to problems for <2.5 GeV/c muons, but is especially a problem for the high momenta, non-contained tracks, where we're very reliant on small differences in deflections from MS to make the measurement.

- So, need a correct electronics simulation, and thus hit simulation. And need to filter out outliers.